210 K CW quantum cascade laser

The latest generation of quantum cascade laser developed by **Applied Optoelectronics Inc** (Sugar Land, TX, USA) has demonstrated continuous-wave operation to a temperature of 210 K (-63°C) - about 35°C higher than the previous record (held by Lucent Technologies). Power was more than 8 mW and wavelength 5.2 μm (with application to 4.6 μm lasers expected). Commercial versions should be available this summer.

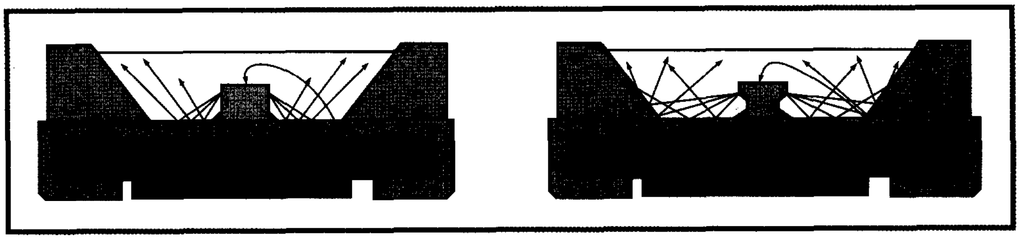
The advance has been achieved through improved material quality and careful thermal engineering of the laser structure (using small, relatively inexpensive, thermoelectric coolers, rather than bulky and expensive cryogenically cooled systems).

The current choice for QCL users is between CW operation at cryogenic temperatures or pulsed operation at close to room temperature. After licensing QCL technology from Lucent last June, AOI has been offering prototype pulsed-mode lasers to R&D customers since September.

However, "potential applications of pulsed laser technology are limited, due to concerns about spectral width, noise and system complexity", said president and CEO Dr Thompson Lin.

"Commercial applications [such as sensitive, spectroscopic chemical detection, accurate analysis of trace gases, non-invasive medical diagnostics, industrial process control and environmental monitoring] demand CW operation at near room temperature, and these results indicate that this is an achievable goal", said Dr James Baillargeon, VP for Telecommunications Technologies.

Osram enhances brightness of its blue SiC-based InGaN LEDs



Schematic diagram comparing (left) emission from a conventionally shaped chip with (right) side emission from the inclined facets of Osram's ATON SiC-based InGaN blue LED chip on to the reflector of a standard LED package.

OSRAM Opto Semiconductors (Regensburg, Germany) has improved the brightness of its "ATON" SiC-based InGaN 5 mm blue LED lamp to 8 mW (from 5 mW at 20 mA when it entered production in August/September - already twice as bright as its standard device). The technology was also licenced to Cree and transferred between June and September 2000.

The process is based on a new technology that improves the external light extraction by optimising the chip's geometry, compensating for the disadvantages of SiC substrates compared to sapphire and closing the brightness gap of InGaN LEDs to other sapphire-based devices.

Increased overlap of incident rays with the outcoupling cone through inclined substrate facets results in a drastic increase of the sideward light extraction. Inclined back-side facets avoid total internal reflection, compensating for the higher refractive index of SiC compared to sapphire. The side emission thus efficiently illuminates the reflector of OSRAM's standard packages (see Figure).

The design is optimised for mechanical stability, for example tipping, adhesion for packaging, thermal and electrical resistance as well as light extraction using chip simulation tools such as ray-tracing techniques.

Advantages include:

- a near doubling of brightness with the same current;
- use of a single process (separation technology);
- no change of epitaxy;
- same grid;
- applicable for all OSRAM's VIS GaN/InGaN chips;
- compatible with OSRAM's standard mounting and packing technology.

Room-temp 2D photonic bandgap laser

Researchers at **Korea's Advanced Institute of Science & Technology** led by Yong-Hee Lee have created and tested thermally and mechanically stable two-dimensional photonic bandgap lasers that operate continuously at room temperature.

By fusing an InP wafer with a GaAs wafer then wet-etching the InP substrate to expose the InGaAsP layer, a thin InGaAsP slab waveguide structure is sandwiched between air and a drilled aluminium oxide layer. Photons are optically confined within the thin slab by total internal reflection on the vertical plane at the high-index InGaAsP/low-index Al_2O_3 interface and a 2D-lattice triangular photonic crystal mirrors formed with periodic holes in the horizontal plane (by chemically assisted ion beam etching down to an AlAs layer that is then wet oxidised into low-index Al_2O_3).

The radiation rate of an excited atom can be controlled by using a cavity to change the distribution of electromagnetic modes near the atom. A Photonic Bandgap Cavity can therefore enhance the desired mode of radiated light while inhibiting unwanted modes.

This particular 2D PBG had seven defects in the horizontal direction. The lattice constant was 400 nm and the holes were no more than 124 nm in radius. Within these parameters, the photonic bandgap for TE-like guided modes is 1220-1625 nm.

The laser cavities were optically pumped by 980 nm InGaAs laser at 1 MHz, with a 10% duty cycle at room temperature. The pump shot size of 4.6 μm was slightly larger than the laser cavity size. This saturated absorption outside the central cavity where the triangular lattice was formed. Room-temperature lasing was observed at 1604 nm (with a line-width of about 0.35 nm) for an incident threshold pump power of 10 mW.

By tailoring the electromagnetic modes, the researchers expect dramatic improvement in light emitting devices: "Zero-threshold lasers, high-efficiency LEDs, and tight-bending waveguides for optical integrated circuits should be realisable in the not-too-distant future".